THE MONTHLY NEWS MAGAZINE OF THE NATIONAL BUREAU OF STANDARDS March 1976

DIMENSIONS NBS

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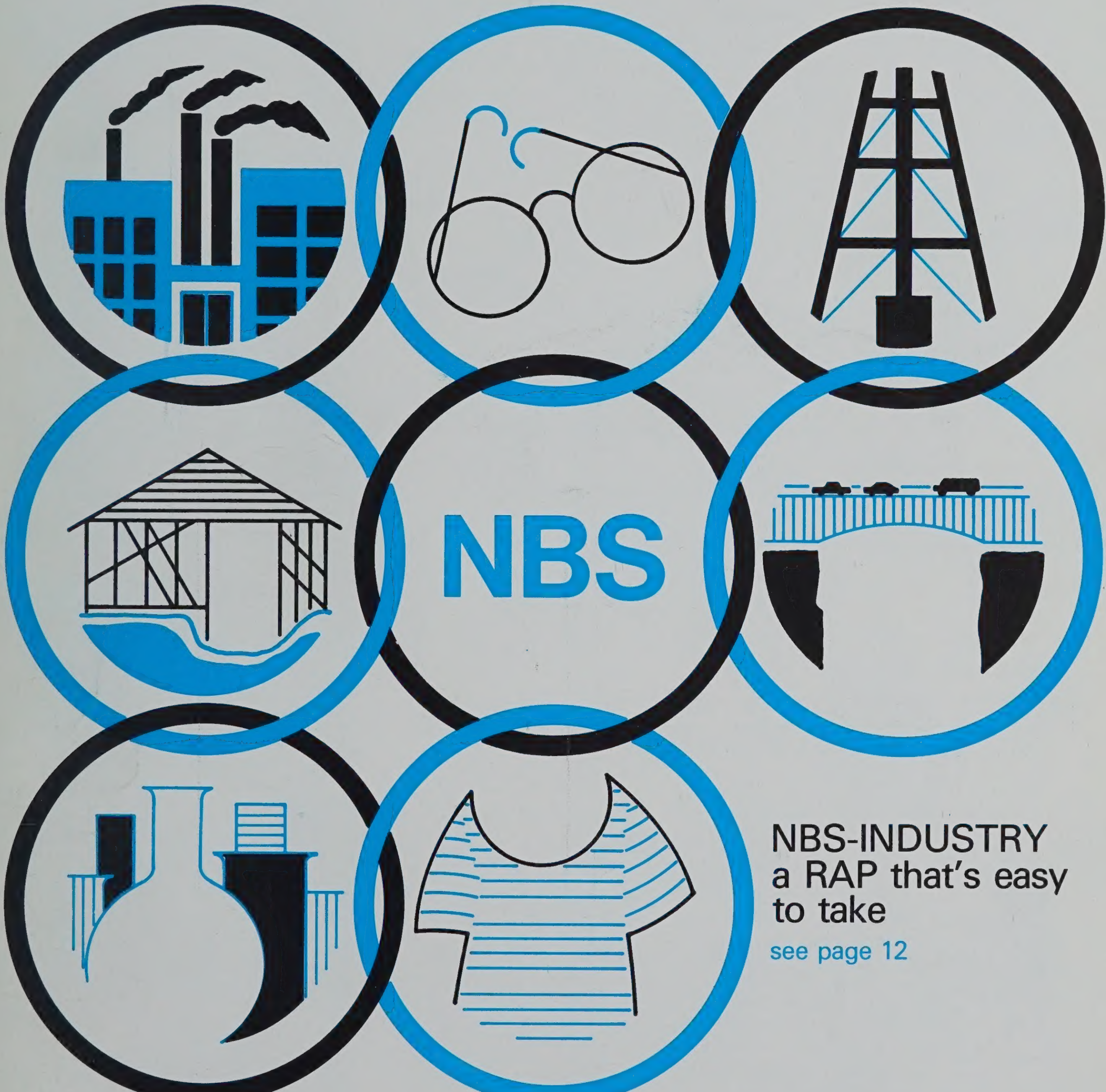

NBS-INDUSTRY a RAP that's easy to take

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NATIONAL BUREAU OF STANDARDS

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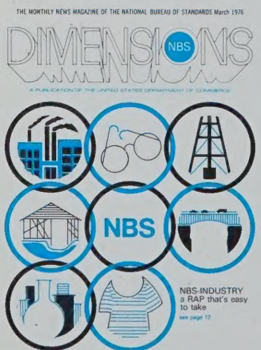
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Cover: Since the 20's, NBS and Industry have worked together in areas of mutual interest. Such cooperative research has benefited NBS, industry, and the public. See page 12 for details.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

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The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Technology
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catching the motorized criminal scientifically

Automotive Paint Reference Collection

by Stanley Lichtenstein
NBS public information specialist

"FOLLOW that car!"

When a getaway car or hit-and-run vehicle has disappeared, police sometimes take up the chase by scientific means. Crime labs and police departments around the country are now using a collection of automotive paint samples from the National Bureau of Standards to trace the motorized criminal. This current contribution of the NBS Law Enforcement Standards Laboratory makes identification of the vanished vehicle more systematic.

The Northern Illinois Police Laboratory in Highland Park reportedly expedites an average of 15 hit-and-run cases a month, using paint samples as a technical aid.

Similarly, southeastern Pennsylvania's Bethlehem Crime Laboratory has reported using the samples about

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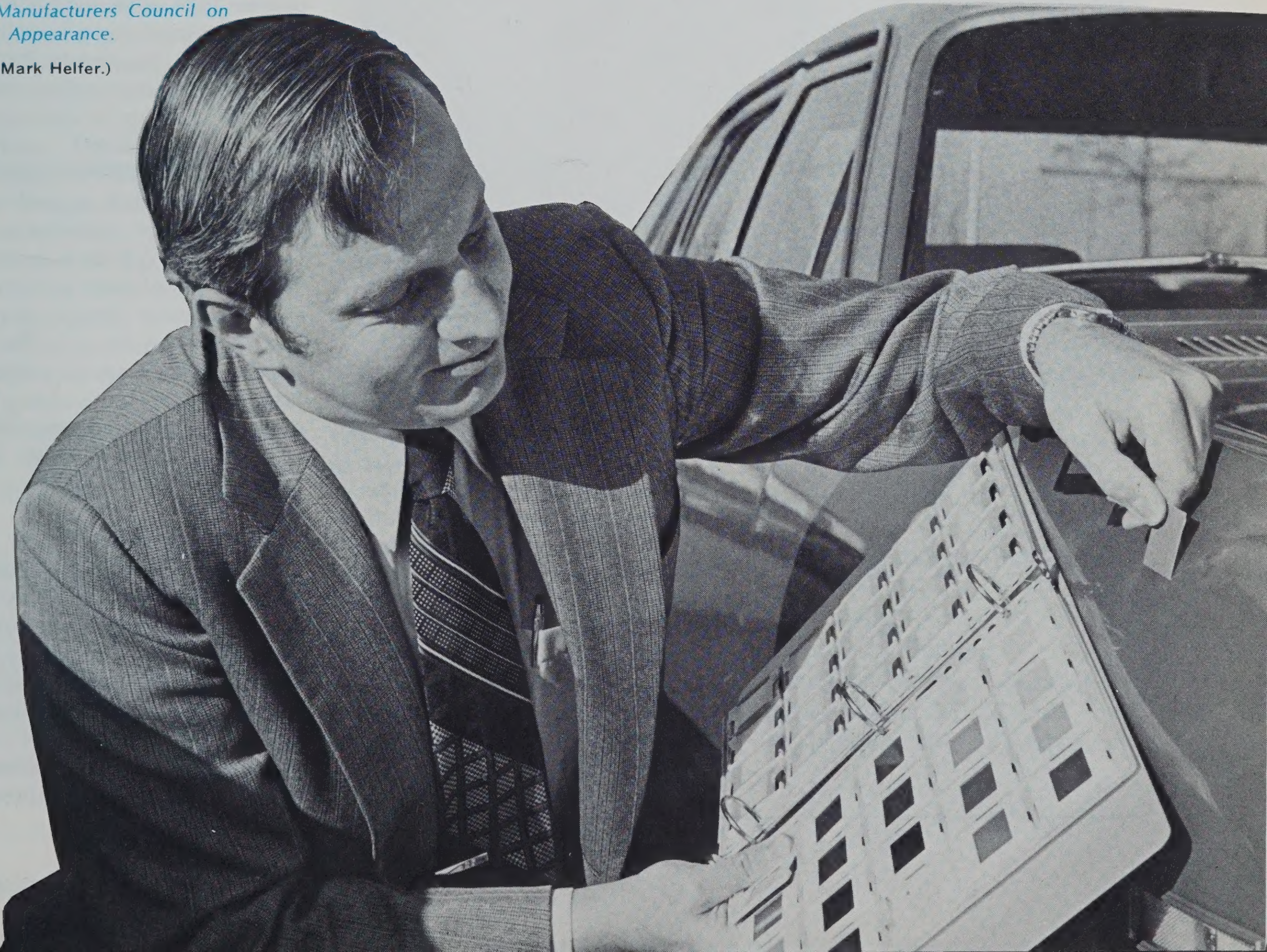


Charles G. Leete, co-author of the automotive paint reference collection, here demonstrates visual matching of sample to vehicle. In actual criminal investigation, a chemical analysis of the paint might help to wind up a case. Leete is a National Bureau of Standards research associate from the Manufacturers Council on Color and Appearance.

(Photos by Mark Helfer.)

Robert Mills, Program Manager for the LESL Investigative Aids Program that assembled the Reference Collection of Automotive Paints.

5 times a week in hit-and-run investigations and considers the collection "a very useful corroborative type reference."

In New York City, the Police Department Crime Laboratory noted that use of the samples led to arrests in three recent hit-and-run cases and called the collection a great timesaver contributing significantly to more effective use of the Department's investigative force.

The Illinois, Pennsylvania, and New York laboratories are among many police investigative facilities around the country that are making effective use of the newly available Reference Collection of Automotive Paints. The pioneer 1974 collection has been succeeded by an improved and expanded 1975 edition. Spurred by the encouragement and constructive criticisms of forensic scientists in various parts of the Nation, project coordinators broadened the 1975 collection to allow for chemical as well as visual comparisons of automotive paints. Current plans call for inclusion in future editions of paint primer samples, as well as paint samples, for foreign cars popular in the U.S. The work is funded by the research center of the Justice Department's Law Enforcement Assistance Administration, the National Institute of Law Enforcement and Criminal Justice.

Paint Colors

Among standard reference collections particularly desired by law enforcement specialists, an automotive paint reference collection ranked high as indicated by responses from forensic laboratories contacted in a 1973 LESL survey.

Paint patches from actual automobile production were provided by manufacturers and suppliers for some 140 colors that appear in the 1974 collection. The samples, about the size of 35-millimeter photographic slides, were cut from panels painted by the original-finish paint suppliers. Arranged in easily removed plastic slide holders housed in three-ring binders, the samples can be routinely and individually examined by investigators both visually and under the microscope. If the book's sequence of color classifications does not suit an investigator's purpose, the samples can be readily rearranged. A technical data supplement to the collection gives the automotive manufacturer's designation for each color and information on reference number, color type (metallic or non-metallic), sales division, sales color name, and model year and models on which each color was used.

Chemical Supplement

RM-75, the sequel to the 1974 edition, contains 74 new paint samples. A 1975 Chemical Supplement presents about 40 additional samples contained in a plastic box. Available with RM-75 to qualified forensic science laboratories, the Chemical Supplement provides additional specimens for chemical comparisons, since frequently more than one paint supplier or type was used for a given color.

Before the 1974 Reference Collection of Automotive Paints appeared, some laboratories worked as best they could with samples obtained from automobile manufacturers or paint companies. Results are said to have been quite limited. The Director of the Houston, Tex., Police Crime Laboratory, for example, reported that color cards he was able to obtain from paint companies were not authentic. Nor did they lend themselves to ready use as the NBS-developed collection does, he added.

Crime Labs Comment

Nearly 70 percent of the Nation's 171 police crime laboratories returned comment forms to Robert Mills, LESL's Investigative Aids program manager, after receiving their 1974 collections. Many investigators were enthusiastic and offered suggestions for expanding and improving the collection. While hit-and-run cases accounted for the preponderance of reported uses of the paint samples, other kinds of applications, including a number of burglaries and robberies involving motor vehicles, were also mentioned.

As the collection is progressively improved, a growing number of motorized criminals will be learning the hard way that their "getaway" may have been something less than that. Mere flecks of paint—so insubstantial that a sneeze from an investigator might blow the evidence away—may provide a crucial link between criminal, vehicle, and crime. When this occurs, the criminal will—literally—have met his "match." □

Research Material 75: Reference Collection of Automotive Paints

RM-75, the 1975 sequel to the collection of automotive paint samples issued in 1974, is now available from the National Bureau of Standards for $33.

A special chemical supplement to the collection will be supplied, free of charge, to qualified forensic science laboratories that make chemical analyses of automotive paints.

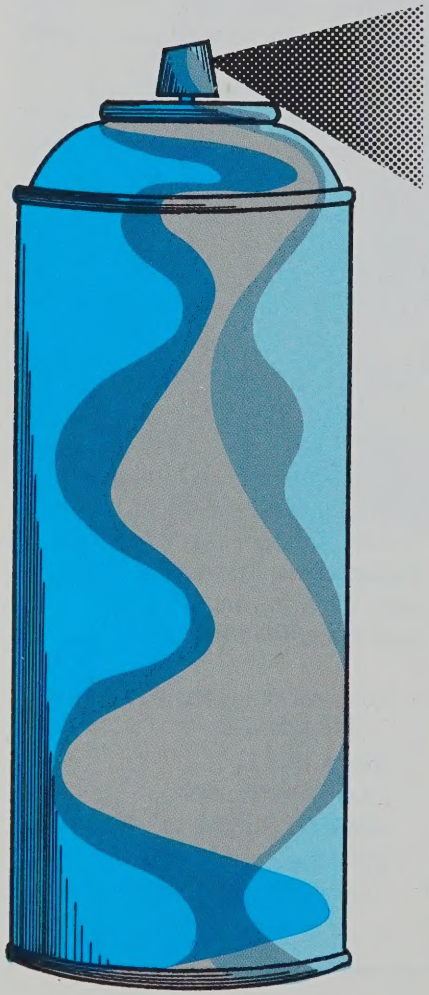
Support for the technical work leading to reference collection development was furnished by the National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, through the NBS Law Enforcement Standards Laboratory. Inquiries and/or orders should be directed to:

Office of Standard Reference
Materials
Room B311
Chemistry Building
National Bureau of Standards
Washington, D.C. 20234
Telephone: 301/921-2045.

Another Piece of the Ozone Puzzle

by Arthur Schach
NBS information specialist

NEW MEASUREMENTS MAY END DISAGREEMENT ON CRITICAL DATA



SCIENTISTS from the Argonne National Laboratory and the National Bureau of Standards appear to have pinned down another set of the critical data needed to settle the current ozone controversy. The scientists report new measurements on the fluorocarbon gases.

Target of the Argonne-NBS study was the probability that a fluorocarbon molecule, once it reaches the upper atmosphere, will absorb an ultraviolet (uv) photon. Measurements were made on the two most common fluorocarbons (also known as chlorofluoromethanes, chlorofluorocarbons, and halocarbons). One of these, fluorocarbon 11, or CFC_3, is used mainly as a propellant in aerosols and a blowing agent for plastic foam insulation, cushions, and other products. The other, fluorocarbon 12, or CF_2Cl_2, is widely used as a coolant in refrigeration and air-conditioning systems and as an aerosol spray propellant.

The Argonne-NBS results agree closely with the values for the probability of uv-photon absorption that had been obtained by F. Sherwood Rowland and Mario J. Molina, the scientists who first proposed the breakdown of the earth's ozone layer. The values differ from earlier measurements by as much as a factor of 2 for fluorocarbon 11 and a factor of 4 for fluorocarbon 12. Added weight is given to these results because they are based on an independent method, one in which the experiments had to contend with a very different set of possible sources of error.

Scientists who participated in the investigation were Russell H. Huebner and David L. Bushnell, Jr. of the Radiological and Environmental Research Division at Argonne and Robert J. Celotta, Stanley R. Mielczarek, and Chris E. Kuyatt of the NBS Institute for Basic Standards. (Bushnell is an undergraduate research participant from the University of Illinois.) The project was supported in part by the Energy Research and Development Administration.

NBS Electron Spectrometer Used

Before the Argonne-NBS measurements, two sets of uv photoabsorption cross sections (probabilities of absorption) for various uv wavelengths had been published. Although the two sets of data were in wide disagreement, both had been obtained by the same method—direct

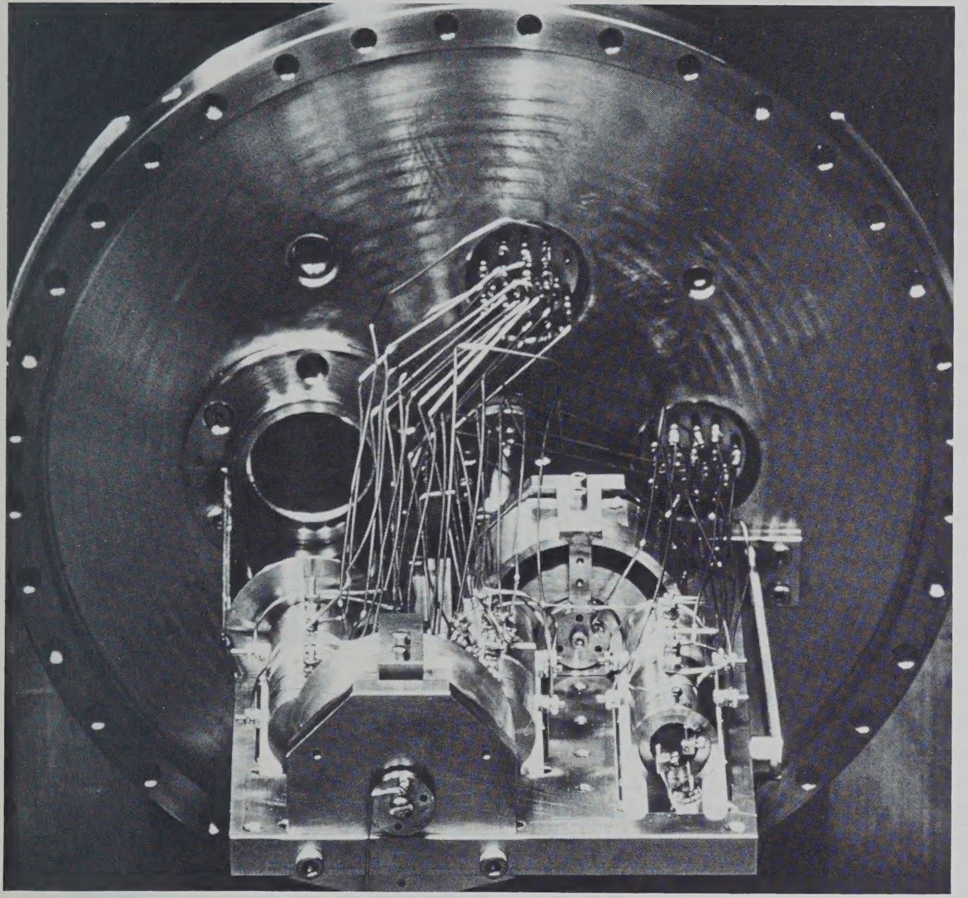


Photo of the NBS electron spectrometer used in the study of fluorocarbons. The circular plate (diam. about 25 cm) on which the device is mounted is attached to a high vacuum system (not shown) when the apparatus is in use.

measurement of the fraction of incident energy absorbed from a uv beam when it passed through a fluorocarbon sample.

In the Argonne-NBS experiment, the absorption probabilities were derived instead by counting the number of electrons that lose precisely determined amounts of energy when they interact with fluorocarbon molecules. Electrons were counted with the NBS Model AN-1 electron spectrometer, a device originally developed for quantitative gas analysis. The measurements were analyzed by a technique that members of the Argonne-NBS team had previously used successfully on acetone vapor and oxygen.

There are two major sections in the NBS electron-spectrometer system—a monochromator and an analyzer. The monochromator generates a parallel beam of electrons all having, within narrow limits, the same energy (100 eV in the present experiment). This beam passes through the fluorocarbon sample gas and then, via an accelerating region, into the analyzer. The analyzer contains an electron detector that counts the electrons that reach it and transmits the total to an on-line computer.

Operation of the spectrometer is based, briefly, on the following procedure. Initially, the analyzer is adjusted so that only electrons that have passed through the sample with zero energy loss (in this experiment, those with energies clustering around 100 eV) can reach the detector. In order

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NBS Electron Spectrometer

To reach the detector (lower right), electrons from the electron gun must pass in turn through a monochromator, a sample of fluorocarbon gas (gas cell), an accelerator and an analyzer.

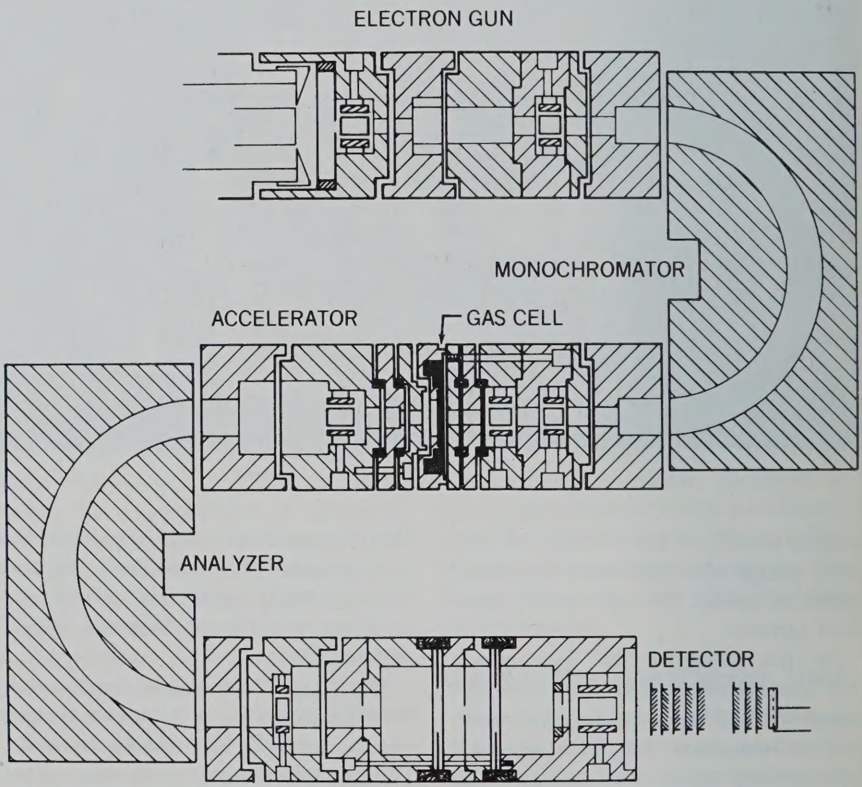
Main part of the monochromator is the electrostatic deflector with the semicircular channel (upper right) which is actually the space between convex and concave metal hemispheres. The hemispheres connect to a battery, producing a radial electric field in the space between, which tends to deflect electrons around the bend. Voltages on the hemispheres and other parts are adjusted so that only electrons with energies very close to 100 eV are bent the right amount to reach the gas sample. (Other electrons collide with the hemisphere walls.)

The electrostatic deflector in the analyzer (lower left) acts in a similar way. It allows only 100-eV electrons coming from the gas cell to reach the detector.

The accelerator raises the energies of all electrons passing through it by the same amount, equal to the voltage across it. If this voltage is zero, then only electrons that have lost zero energy interacting with the fluorocarbon molecules will reach the detector. But if the accelerator voltage is 5 volts, for example, then only those electrons that have lost 5 eV in the gas cell will get to the detector. Thus a graph of the detector output against the accelerator voltage represents the energy-loss spectrum of the electron beam emerging from the fluorocarbon sample.

to have the detector receive, instead, those electrons whose energy has been reduced by a certain amount, the accelerating voltage need only be adjusted to increase all electron energies by that same amount just before the electrons enter the analyzer.

From the electron energy-loss counts one can calculate the relative probability of energy absorption by the fluorocarbon molecules. The calculated probability, in turn, is directly proportional to the photoabsorption cross section or absorption coefficient for ultraviolet light that would produce the same effect. It is believed that the cross sections determined in this way can be relied on to better than ±15 percent for uv wavelengths longer than 80 nm (photon energies less than 15 eV). □



PIECING TOGETHER THE PUZZLE

A still-raging scientific controversy on whether man may be rapidly destroying a portion of the earth's atmosphere surfaced publicly in June 1974. At that time, the British journal *Nature* published the contention of University of California scientists Mario J. Molina and F. Sherwood Rowland that fluorocarbon gases — used in aerosol cans and refrigerators—threaten the earth's protective layer of ozone. It is generally accepted that the ozone layer shields the surface of the earth from ultraviolet radiation that produces skin cancer in humans and is also harmful to other forms of life.

In a 5-part theory, Molina and Rowland proposed that:

(1) fluorocarbon molecules could rise to the upper atmosphere where

(2) they are made unstable by absorbing uv photons so that

(3) many of them split into free chlorine and fluorocarbon radicals, after which

(4) the chlorine acts as a catalyst to convert ozone into oxygen

(5) at a rate that could soon (perhaps in a matter of years) reduce the shielding power of the ozone layer to a dangerously low level.

Government, industry and science experts were not long in realizing that the possible threat to the ozone layer deserved serious study at the very least, and numerous research projects were therefore initiated. Many key data needed for analyzing the complex chemical-atmospheric-solar radiation interactions were not available or, if available, were insufficiently accurate or even, as in the case of the photoabsorption cross sections, in strong disagreement with one another.

The Argonne-NBS data project has done something, perhaps a good deal, to clarify the situation in regard to the absorption of uv radiation by fluorocarbon molecules hypothesized by Molina and Rowland, which is like finding one piece of a large jig-saw puzzle.

This piece, however, fits together with a result concerning the splitting of unstable fluorocarbon molecules into free chlorine and fluorocarbon radicals announced recently by NBS chemists Pierre J. Ausloos and Richard E. Rebbert (DIMENSIONS/NBS, November 1975). These scientists found that essentially every molecule that absorbs a photon of uv will proceed to break up, yielding at least one free chlorine atom.

In still another recent NBS study, chemists Michael J. Kurylo and Walter Braun conclude that the rate of ozone depletion by chlorine atoms under stratospheric conditions, is only half as rapid as had previously been thought (DIMENSIONS/NBS, November 1975). Parallel studies at the Universities of Maryland and Pittsburgh and at the Queen Mary College in London confirm this finding.

It is probably too soon to draw any general conclusions from these new results, even if we combine them with earlier well-established facts. Information is still needed, for example, on the effects of temperature on the various chemical reactions that might be involved. Most past measurements were not made at the low temperatures that occur in the upper atmosphere. Efforts, at NBS, to answer such questions are being made by Arnold M. Bass, who is studying the effect of temperature on the photoabsorption cross sections of fluorocarbons, and by Carleton Howard of the National Oceanic and Atmospheric Administration and Kenneth Evenson of NBS at the Boulder laboratories, who are using the laser magnetic resonance technique to investigate mechanisms and time rates of fluorocarbon reactions with the hydroxyl radical and plan to study their temperature dependence.

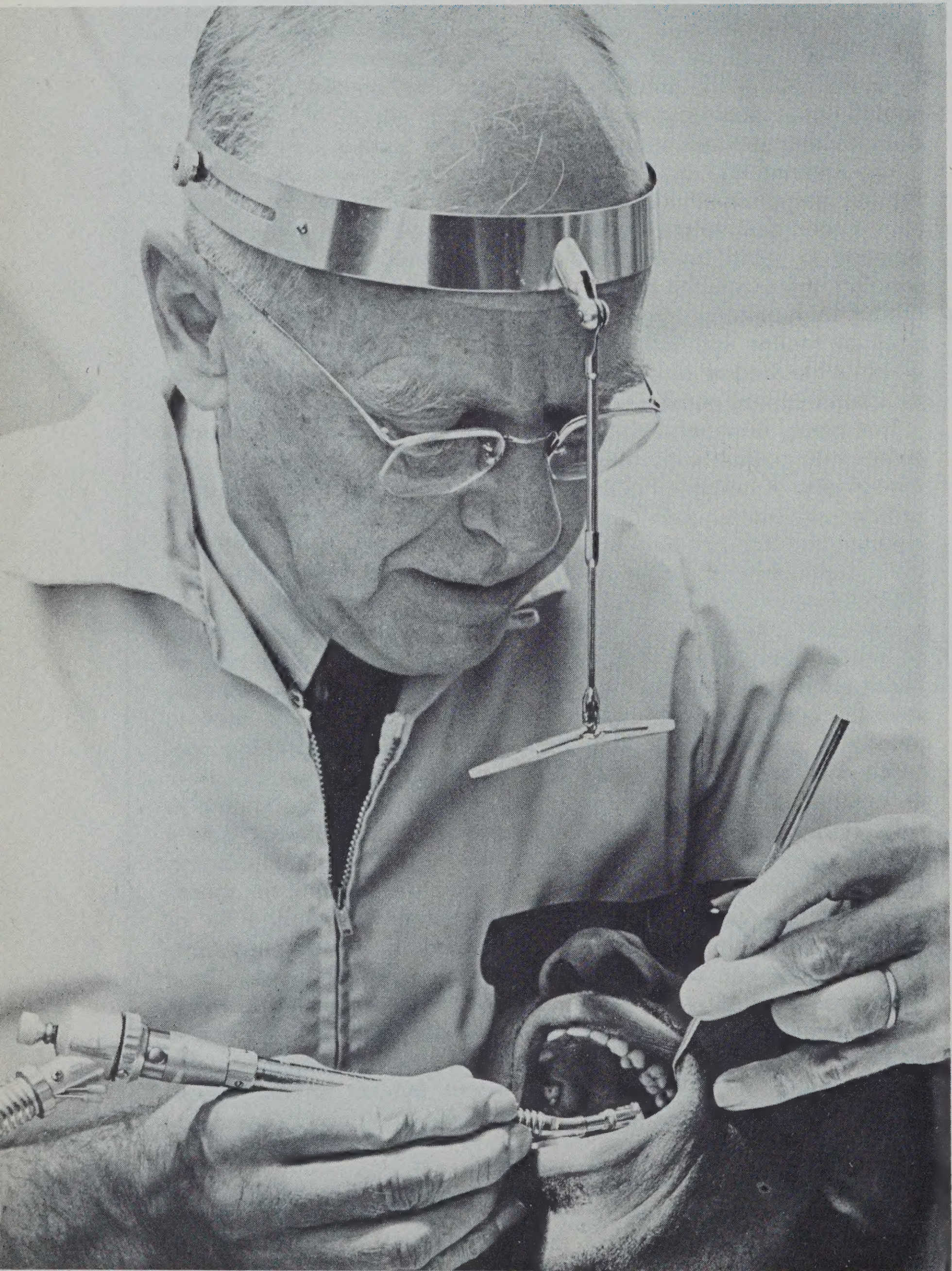
NBS is now participating in preliminary discussions with a view to bringing fluorocarbon researchers together for a conference on standardization of methods for measuring fluorocarbon concentrations. These are the methods used to measure how much fluorocarbon is present, for example, at different heights in the atmosphere.

Better Dental Materials

MEAN FEWER TRIPS TO THE DENTIST

by Michael Baum
staff writer

(Photos by Mark Helfer.)



MOST people remember work on their teeth as an unpleasant experience, and few look forward to a repeat performance. But when fillings loosen and deteriorate they have to be replaced, and it's back to the dentist for another session.

Although the perfect never-needs-replacing dental filling is still in the future, scientists in the American Dental Association's Health Foundation Research Unit at the National Bureau of Standards, together with NBS personnel, are working on ways to prolong the life of fillings—and hopefully reduce the number of trips you have to make to the dentist for "maintenance."

Funded by the ADA and the National Institute of Dental Research, the researchers are studying the factors that affect the durability and life of composite resins, a comparatively new class of materials for restoring teeth that dates from the 1950's.

From the point of view of durability, the best materials for filling teeth are still gold or silver alloys. For filling cavities in the large grinding teeth in the back of the mouth, silver amalgam is most commonly used, since composite resins are not durable enough to withstand stress for a reasonably long period such as 5 or more years.

But metal fillings have distinct disadvantages. When front teeth chip, crack, or decay, most patients rule out the use of metal fillings because people prefer a natural appearance in the front teeth.

For almost 100 years, silicate cements provided a solution of sorts to the problems posed by cavities in the front teeth. These cements are made from a special powdered alumino-silica glass. When partly dissolved in phosphoric acid, the cement formed can be used as a filling in the front teeth with a color and translucence that nearly matches the tooth. Silicate cements have their drawbacks, too. They are not very strong, they can chip and break, and when unlined, they are toxic to the dental pulp, the central part of the tooth. These cements also have a comparatively short span of usefulness: after an average of 5 years, they disintegrate and must be replaced.

A "plastic" filling material, a self-hardening acrylic, was introduced in the United States in 1948. It enjoyed a brief vogue, but fell into disfavor because the acrylic tended to shrink, discolor, encourage secondary decay, and cause inflammation of the dental pulp.

The development of composite resins within the past 20 years has given dentistry a new and better alternative. These composites consist of a minor amount of a resin that acts as a glue to hold together particles of a filler such as glass or quartz.

Several variations using epoxies as the resin component were tried and discarded. In 1956, an American Dental Association research team at the National Bureau of Standards, headed by Dr. R. L. Bowen, developed a monomer, BIS-GMA, that combined elements of both the acrylics and the epoxies. BIS-GMA is now the basic resin in commercial composites, and also in most commercial pit and fissure sealants. (For a discussion of BIS-GMA in sealants see "Fluorides and Sealants: Stopping Cavities Before They Start," DIMENSIONS, November 1975.)

Composites using BIS-GMA have already had an impact on modern dentistry. Manufactured under a number of brands, they are filled with small beads of various types of glass or quartz, ranging from about 1 to 30 micrometers in diameter.

When properly used to restore the front teeth, the composites, according to Bowen, are serviceable for about 8-10 years—twice the durability of the silicate cements. A 1974 survey of dentists by the American Dental Trade Association estimated that between 1970 and 1974, the use of composites increased over 250 percent, while the use of silicates declined over 60 percent.

There are a number of reasons why a composite filling may wear down, when used to restore the back teeth, but the ADA researchers believe that a key factor is the failure of the resin to adhere well enough to the particles used to reinforce it. If the glass particles in the composite do not "stick" tightly to the plastic, the top layer of particles in the filling will eventually come loose and wash away, leaving only the resin. The resin in turn wears away, exposing a new layer of glass beads, and the process continues.

According to Bowen, "We are now investigating a way to get a better bond between the filler and the resin. Simple as this sounds, it may have a very profound effect on the overall durability of the restorations in the tooth."

Commercial dental composites presently have only one means of getting the filler to adhere to the resin, a so-called "coupling agent" that is one of a number of related chemicals called "silanes." The silane condenses on the surface of the particles, forming a sort of coating on the glass. The silane then bonds chemically with the BIS-GMA resin.

The silane-glass connection is the weakest part of the structure, according to Bowen and his associates; however, they are investigating a more elegant solution that promises a great improvement in the durability of these composites. The idea is complex and rests on the nature of certain glasses with high silica content and a process called phase separation.

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NBS RAPS WITH INDUSTRY

IN one laboratory a chemist refines sugar to pure sucrose and dissolves the sucrose in water to measure its "optical rotation." His results may lead to a new definition of °S, the "degree sugar" by which buyers and sellers judge the composition of the sugar they handle.

In another section researchers record the X-ray diffraction patterns for different crystalline substances. Their results are printed up on small cards and filed according to pattern. If the pattern of an unknown material, perhaps a drug, a ceramic, or a cement, matches one of 15,000 cards now on file, it can be identified by its "crystal fingerprint."

Down a third corridor a variety of chemists, crystallographers, dentists and other specialists study ways to improve the various synthetic materials used in modern dentistry to repair and replace teeth.

All of these projects at the National Bureau of Standards are in fields normally of interest to that agency. What is unique is that the more than 60 men and women currently working on these and other important research projects are not employees of the Bureau. They are Research Associates, trained scientists and technicians sponsored by industrial companies and trade and professional organizations to work at NBS on special projects of interest to both the sponsor and the Bureau. All sides profit by the work of the Research Associates, including the public, which ultimately benefits from the results of their research.

"In principle and practice, the Research Associate Program offers industry and government the opportunity to establish a unique interface for communication," notes C. Howard Adams. Adams, a Fire Test Manager for the Monsanto Company, served for 2 years as a Research Associate at NBS.

Peter de Bruyn, the NBS Industrial Liaison Officer who manages the Research Associate Program, sees the program in terms of his own long experience in industry. "Perhaps the simplest way to put it is to say that there are two situations in the course of my own industrial career where I wish I had been aware of the availability of the program: one, when I was in a position which might have offered me the opportunity to serve as a Research Associate for my company, the other, when I was involved in research management and might have been able to send one of my people to NBS as a Research Associate."

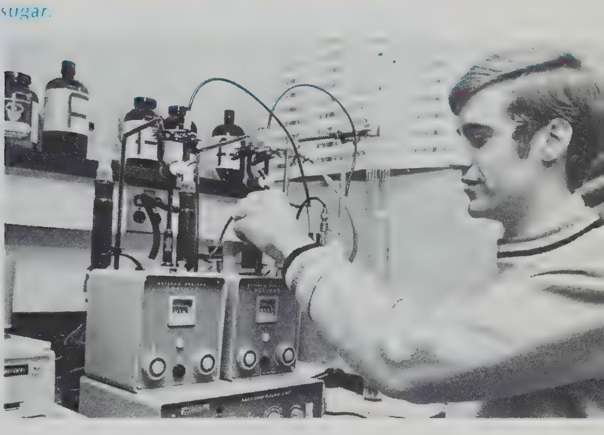
A glance at some of the Research Associates and their projects gives a good idea of the nature and scope of the program.

Alma Coats, a chemist, is employed by Hooker Chemical. She, like Adams before her, is one of a number of industrial representatives working at the NBS Center for Fire Research under the sponsorship of the Society of the Plastics Industry.

As a Research Associate, her salary, fringe benefits, and travel arrangements are handled by her company. She works at the NBS labs in Gaithersburg, and is provided by the Bureau with technical supervision, office and laboratory space, supplies and clerical services, and in general anything else available to a regular employee of the Bureau of Standards.

Left: Dr. Gerald Vogel, Research Associate with the American Dental Association Health Foundation Research Unit, examines the tip of a subminiature pH electrode. The tiny probe, only 3 microns in diameter at the tip, is used to measure the acidity of microscopic volumes of fluid removed from tooth enamel.

Below: Dr. Arthur Cummings, a Research Associate from the International Sugar Research Foundation, adjusts an automatic titrator to measure precisely the amount of water in samples of sugar crystals. Excess water in surgar crystals affects the accuracy of the tests used by dealers to determine the composition of commercial sugar.



(Photos by Mark Helfer.)

Coats' particular project involves studying the toxicity of combustion products—smoke and fumes—produced by burning plastics. For her, one of the great advantages of working at the Bureau is the availability of special fire test facilities. It is possible at NBS to conduct full scale "burns" of rooms and vehicles inside a 6,500 cubic meter test chamber—a facility that most companies do not have.

The work Coats does is useful to her company, which has a strong interest in fire-retardant chemicals, and to the other companies that jointly make up the Society of the Plastics Industry. It is useful to NBS too. Part of Coats' research went into a recently released NBS report on fire hazards in subway cars built for Metrorail, the Washington, D.C. subway system.

Because of its public nature, the results of work done at the Bureau fall in the public domain. The benefits to the public from the Research Associate Program over the years have been impressive.

The American Dental Association research program provides a good example. First started in 1928, the ADA program has continued, with occasional changes in staff, ever since. The ADA program was begun to study the properties of amalgams, the metal alloy most commonly used in dental fillings. Since 1928, the ADA Research Associates have produced scientific standards for dental materials, developed new techniques in dentistry such as the panoramic X-ray, now in widespread clinical use, and for a long time handled testing of dental materials under the ADA's certification program.

The ADA researchers at NBS also produced the turbine contra-angle highspeed handpiece, a hydraulic turbine for dental drills that led to the modern equipment that has revolutionized dental surgery. More recently, an ADA Research Associate developed the monomer BIS-GMA, a binder widely used in reinforced fillings and to seal teeth.

During the past 47 years the Research Associates from the ADA, in

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cooperation with NBS personnel, have issued over 600 publications, including books, reports and articles in various professional journals.

There are other places, of course, where this work could be done, but, notes Dr. George Paffenbarger, senior research associate of the ADA unit, "In no instance would the ADA have the facilities, or expertise, or tremendous laboratories such as are available here at the National Bureau of Standards."

Paffenbarger, who became a Research Associate in 1929, was the first dentist to work full time in the program.

The American Society for Testing and Materials also started a Research Associate Program at the Bureau in 1929. In that year ASTM Committee C-1 on Cement began work at NBS. In collaboration with a similar committee on concrete, Committee C-1 formed what was to become in 1960 the "Cement and Concrete Reference Laboratory," an ambitious project to promote uniformity among concrete and cement testing laboratories across the United States.

Provided with office space, use of the motor pool, and various special services of the Bureau, the CCRL regularly inspects laboratories on "tours" that take from 2 to 3 years and cover over 500 installations in the United States and Canada. The Bureau lends the CCRL technical services and its own prestige as a standards organization.

Current and recent Research Associate Programs have included:

- a project sponsored by IBM to develop criteria for magnetic tape performance;
- a study sponsored by Underwriters' Laboratories, Inc. on how interior furnishings behave during real-life fire situations; and,
- a program by the Edison Electric Institute to maintain and improve the accuracy of techniques used to measure kilowatthours of electricity use. An important outgrowth of this program has been the establishment by NBS of a Measurement Assurance Program which enables the electric utility industry to validate the performance of their own measurement laboratories on a continuing basis. It is one of several such programs dealing with various physical quantities of industrial and public concern.

The advantages of having a company scientist or engineer working on non-proprietary matters (research that will not be held secret) at the Bureau of Standards have attracted more than 400 companies and trade organizations and some 1500 individuals to the Bureau since the program began.

Some of the advantages are obvious. There is the use of the NBS computer and libraries, the laboratories and special research facilities that are difficult to match anywhere else. There is the advantage of working with the NBS staff, which includes many scientists of recognized importance in their fields, and benefitting from their readily available assistance in a great variety of technical disciplines.

Other attractions are more subtle, but just as important. Being in a government lab, for one thing, makes it easier to "keep in touch."

"Being here in Washington, I think, is an important thing," remarks Coats, "You get the pulsations of what's happening on Capitol Hill so much faster than you do in western New York." In addition, she notes, the company representative is expected to keep in touch with other scientists at the Bureau, and the representatives from other organizations and companies, and to keep abreast of proposed standards and developments in testing methods that may affect the company's products.

Adams, from Monsanto, sees this direct involvement in the process of developing a sound technical basis for standards as valuable to both industry and the public. "Both sides have a hand in it. It leads to very rational standards that will protect the public and keep industry on a sound footing."

Above. Alma Coats, a Research Associate sponsored by the Society of the Plastics Industry, examines a furnace used in assessing the toxicity of smoke and fumes from burning plastics.

Left. Marlene Morris, Director of the Joint Committee on Powder Diffraction Standards Associateship, demonstrates an X-ray diffraction unit. A non-profit organization for collecting crystallographic data, the JCPDS has maintained an associateship at NBS since 1949.

Adams himself worked on one such project, which resulted in a new method for testing the flammability of floor coverings in corridors and exitways. The new procedure will soon replace an older testing method which, it was felt, did not accurately test the resistance of such floor coverings to fire.

The Research Associates who have gone through the program are also likely to point to the value of the friendships and professional relationships formed while at NBS.

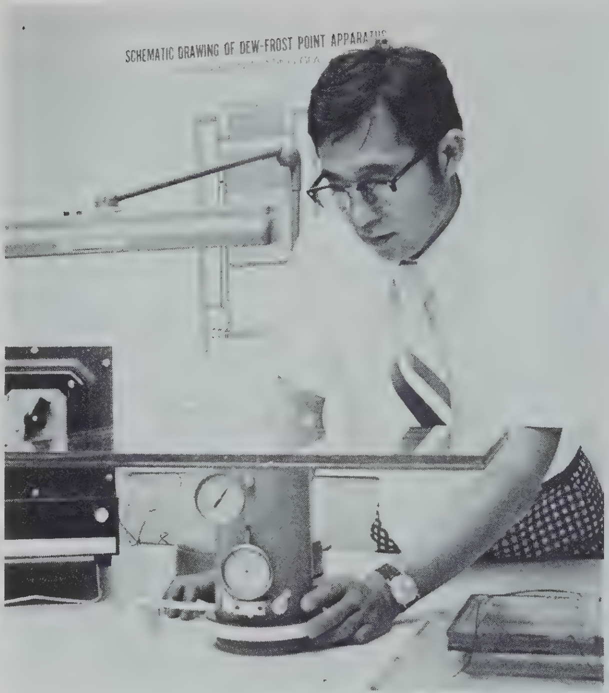
John Martin, who is now a senior research engineer at U.S. Steel, worked as a Research Associate. While at NBS, he developed a method for measuring the concentration of oxygen and nitrogen in steel at remarkably low levels (down to 4.5 parts per million of oxygen). His work resulted in improved measurement capabilities which enabled NBS to issue a new Standard Reference Material for gas concentrations in steel. That was in 1968. Martin still calls his associates in the Bureau on occasions when they can supply advice or the answer to a question, and he in turn receives calls for advice from scientists at NBS. "I think the liaisons alone that you get from the program are beneficial," he says.

The Bureau of Standards has long been proud of the Research Associate Program. The individuals and sponsoring organizations who have participated in it also seem pleased, as correspondence from one recent sponsor suggests. Attached to an announcement of the promotion of a Research Associate shortly after his return to his company is a note from the Director of Research reading, "Bill's experience at the Bureau helped qualify him for this promotion." Many organizations have followed their initial sponsorship with a succession of programs.

turn page

RAPS *continued*

Things don't always go smoothly —one RA noted that special equipment seems to be inordinately hard to get, another felt that his program was not as well defined as it should have been—but the general feeling is, as Coats expressed it," In my particular assignment I find the people I come in contact with very responsive, willing to accept suggestions and willing to offer suggestions. Personally, I've been made to feel a part of the team." *MB* ☐



Dr. Mahn Hee Hahn, Research Associate from the American Society for Testing and Materials, with the dew/frost point apparatus he developed to measure the moisture content of the air space in sealed insulating glass. The device received an IR-100 award from Industrial Research magazine as one of the most significant new technical products of 1975.

RESEARCH ASSOCIATES

The modern history of the Research Associate Program dates from only about 10 years ago, but its origins are older than the Bureau itself. The authority for the program traces back to 1892, when Federal legislation was enacted to "encourage the establishment and endowment of institutions of learning at the national capital" by making the scientific and technical facilities of the government available to scientists and students.

Early in 1919, the National Industrial Conference Board proposed to then Secretary of Commerce William C. Redfield a program of cooperation between industry and the Department, and in particular the National Bureau of Standards.

The Research Associate Program at NBS was begun by Dr. Samuel Stratton, the first Director of the Bureau, who recognized the value of such a program during the severe postwar staff shortage. In 1920 there were 17 Research Associates at the Bureau, working in such fields as metallurgy and refrigeration. By 1925, the number was up to 61.

The Research Associate Program continued on more or less informal lines until 1965, when Dr. Allen V. Astin, then Director, established the Office of Industrial Services under Robert L. Stern to "rejuvenate" the program and provide a focus for development and management of the activity.

Starting from a base of 10 separate projects and about 20 Research Associates, Stern began an aggressive campaign to expand the program and provide a uniform basis for its conduct.

In 1966, Peter R. de Bruyn joined NBS as Industrial Liaison Officer to assist in following up the inquiries resulting from the campaign, working first with Stern and subsequently with Dr. George S. Gordon, who headed the office from early 1967 to mid-1970. de Bruyn has since had full responsibility for development and management of the program as part of his broad concern for the Bureau's industrial relationships. As 1976 begins, 19 programs involving 62 Research Associates are active at NBS, with negotiations in process for 4 new programs and 9 new Research Associates. In a given year, the "turnover" in programs is on the order of 8 to 10 and in Research Associates about twice this number. Thus during any 12 month period, some 25 to 30 different programs will have been active, involving perhaps 85 to 90 individuals.

HOW TO ASSOCIATE WITH RESEARCH AT NBS

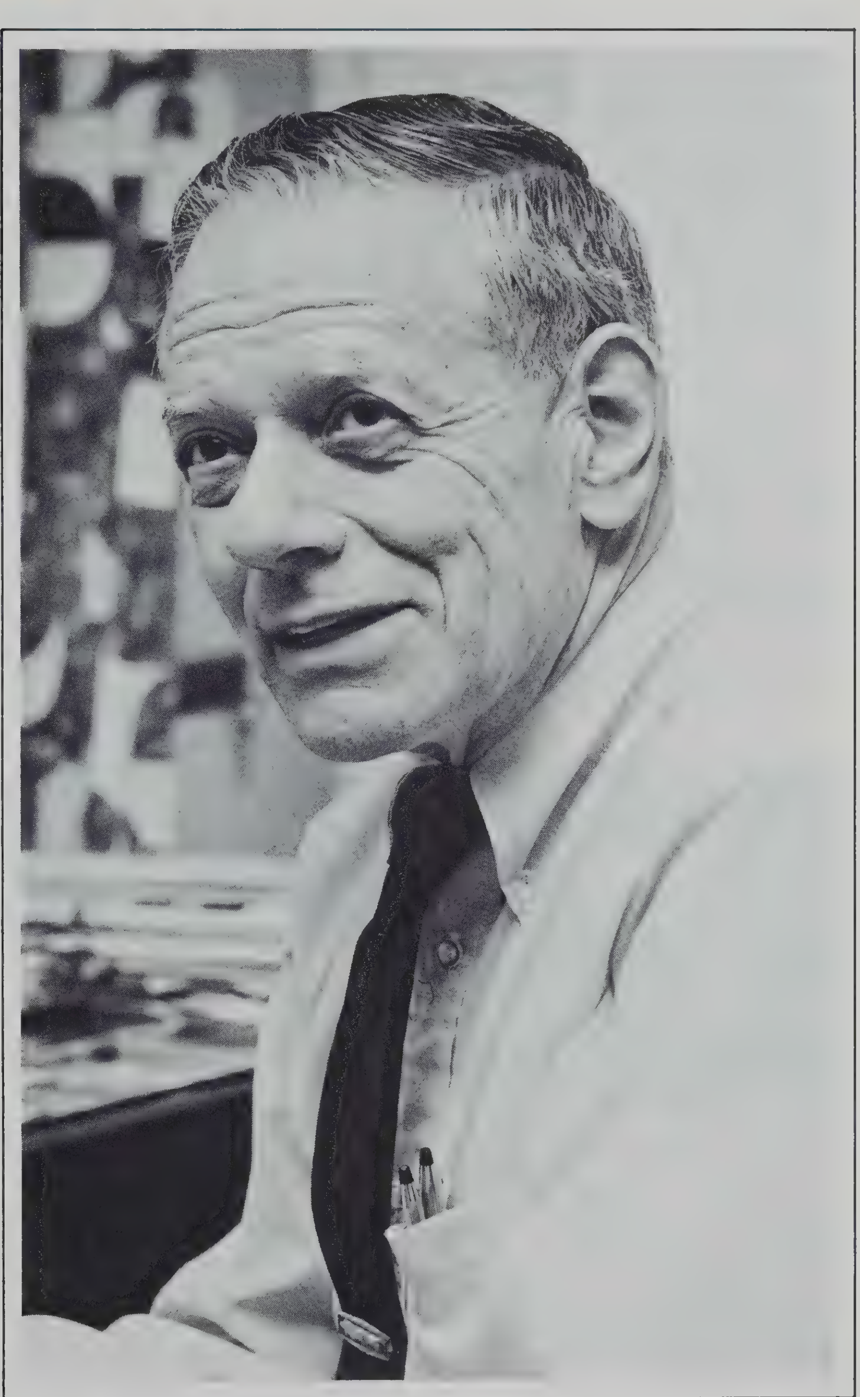
Research Associate Programs still have rather informal beginnings. The initiative may come from either industry or the Bureau, depending upon who first conceives a project that might be of interest to the other.

Representatives of a prospective sponsor get together with the appropriate members of the NBS staff at the invitation of either party to discuss the details of a potential program. Peter R. de Bruyn, the Bureau's Industrial Liaison Officer, who is responsible for developing and managing the activity, works with them to establish a mutually acceptable project definition, statement of objectives, and work plan. Following this, with the assistance of members of the NBS legal, patent, budget and accounting staffs as necessary, he prepares and negotiates with the sponsor's management personnel a Memorandum of Agreement describing the program and setting forth the terms and conditions governing the relationship between the sponsoring organizations and NBS.

The base criteria for a program are simple: it must have nonproprietary objectives; it must be within the scope of NBS activities and interests; and it must offer the prospect of publishable results of interest and significance to the industrial and technical communities represented, and thus ultimately to the public.

The programs start when convenient to both parties and may last from a few months to several years. They may be staffed by one or many Associates. The ADA research unit, something of an unusual case, currently has 22, including physical chemists, ceramists, metallurgists, dentists, crystallographers, a mathematician, and supporting personnel.

To be eligible for the program, a person must have an appropriate academic background and enough experience to be able to perform independent research. The sponsoring organization, with the advice and consent of the Bureau, selects its own Research Associates, who remain the employees of that organization.



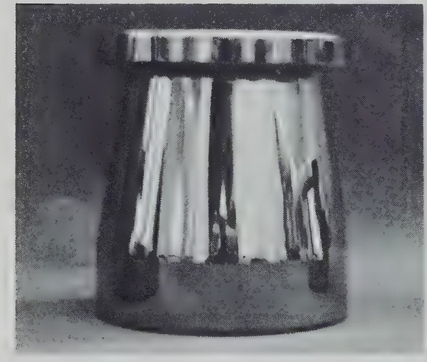
Peter R. de Bruyn, Industrial Liaison Officer at NBS since 1966. "You can't be insular and still solve problems. The Research Associate Program is one of our most effective mediums for the exchange of ideas."

HIGHLIGHTS

Arizona No. 47

On January 9, Arizona became the 47th State to receive new standards under an NBS program to replace the weights and measures standards in all 50 States, the District of Columbia, Puerto Rico, and the Virgin Islands. Included in the 95 piece set of instruments are standards both in the U.S. customary system and the metric system.

The program was initiated at the request of the National Conference on Weights and Measures because many of the standards and instruments formerly used by the States in weights and measures administration were provided by the Federal Government 100 years ago or more. NBS is supervising replacement of the State standards to update and extend measurement competence throughout the Nation, as required by scientific and technological advances.



Consumer Product Director

Dr. Stanley I. Warshaw, a ceramic engineer with extensive experience in research and development and management, has been appointed director of the NBS Center for Consumer Product Technology (CCPT). The Center performs research and development necessary to evaluate the safety, energy efficiency, and other performance characteristics of consumer products and equipment for the law enforcement community.

Since 1972, Warshaw had been general manager for development and engineering for the American Standard Corporation, New Brunswick, N.J. In this position Warshaw was concerned with intermediate and long range research and engineering requirements for new products, evaluation of the economics of technical program proposals, and design of methods for accomplishing future objectives.

Smoke Detectors

Current NBS studies to characterize different types of smoke may lead to more "selective" smoke detectors—detectors that can distinguish smoke from different sources. The studies show that smoke from the pyrolysis of different materials such as urethane and polyvinylchloride (PVC) can be identified by inspecting the curves of scattering intensity as a function of angle and direction of polarization of the incident light. Data collected so far have shown that these signatures may be used to identify the source of the smoke. With such information, it may be possible to design detectors which are sensitive to specific characteristics, thereby reducing the false alarm rate.

Cutting Fuel Costs

Reducing the nozzle size on existing oil-fired furnaces might cut home fuel bills 4 to 8 percent. This conclusion comes from a recent study conducted for NBS and the Federal Energy Administration on oil-fired residential heating plants in the New England area. Various potential energy-saving procedures were evaluated, and nozzle size was reduced on installations that had previously been overfired in respect to heating load. Average fuel savings during the test period amounted to 4.8 percent. On units whose percentage of excess combustion air was either maintained or decreased, the average fuel savings was 7.8 percent. Two major oil companies have started offering programs to optimize oil burner nozzle size.

Annual Report

An overview of science and technology at the National Bureau of Standards in the year 1975 is presented in the latest NBS Annual Report. Programs, staff, funding, accomplishments, and goals are discussed in relation to such major National priorities as energy production and conservation, consumer product technology, computer use, fire safety, industrial needs, and accurate measurement standards and techniques. The report is available for $1.05 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order by SD Catalog No. C13.10:437. ☐

University of Florida, Gainesville, Selected to Test Integrated Utilities System Concepts

THE University of Florida at Gainesville has been selected to test a new concept in energy generation and conservation that could mean a 42 percent energy savings for the University.

The selection was announced jointly by Jordan D. Lewis, director of the National Bureau of Standards' Experimental Technology Incentives Program (ETIP), Gerrit D. Fremouw, director of the Office of Facilities Engineering and Property Management in the Department of Health, Education and Welfare (HEW), and Robert Q. Marston, President of the University of Florida, Gainesville.

The concept, called "Integrated Utilities System" (IUS), comprises five utility subsystems: onsite generation of some portion of needed electric power, heating-ventilating-air conditioning and hot water, solid waste handling, liquid waste handling, and potable water conservation.

When designed to work together and complement each other using existing technology, these subsystems are expected to reduce energy input to the institution by as much as 42 percent with no reduction of the level of utility services. They are also expected to reduce environmental pollution.

The energy savings is gained through capture of energy normally lost at central electric power stations, in the transmission lines from the power station to the institution, and in normal solid waste disposal.

The overall strategy for the project is to seek a cost-effective demonstration of energy savings and pollution control in a large institution that has similar utility needs as a community, thereby providing a national model for other institutions.

ETIP is the sponsor of the project carried out through HEW. The ETIP objective is to experiment with the idea that existing technology can be brought quickly to the marketplace and applied if managers of public institutions provide the opportunities for private sector organizations to respond. The IUS project is only one of a number of ETIP projects to improve the environment for innovation through experiments with procurement, regulation, civilian research and development, and subsidies.

The HEW Office of Planning and Development acts as the project office for the IUS effort.

The first phase of the project will be to determine the technological feasibility and economic desirability of installing an IUS by the University of Florida using the University's resources. The second phase will be to prepare an engineering conceptual design of the IUS. The onsite engineering work will be done by the government's consultant contractor, Reynolds, Smith and Hills, architects, engineers and planners, of Jacksonville, Fla.

Once this preliminary work is complete, the university management will then decide whether to proceed to final design and construction, contingent on availability of University construction monies. □

NBS Issues Privacy Act Index

THE National Bureau of Standards has issued an index of design requirements for automated systems to assist Federal agencies in implementing the provisions of the Privacy Act of 1974.

The index is derived from the implementation guidelines for the Privacy Act as provided by the Office of Management and Budget in the *Federal Register* on July 1, 1975.

The index results from activities of the Federal Information Processing Task Group 15, a public advisory committee established to advise the NBS Institute for Computer Sciences and Technology on computer systems security.

The "Index of Automated System Design Requirements as Derived from the OMB Privacy Act Implementation Guidelines," identified as NBSIR 75-909, Accession Number (PB 246-863), is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151, at a cost of $3.50. Microfiche is available for $2.25. □

New Publication Available on Secondary Ion Mass Spectrometry

A new publication describing the the current state of secondary ion mass spectrometry as an emerging measurement technology in microanalysis has been published by the National Bureau of Standards.

"This is the only book currently available that is exclusively devoted to this subject and as such should be of interest and help to actual or potential workers in the fields of secondary ion mass spectrometry and surface analysis," according to the editors, Dr. F. K. J. Heinrich and Dr. D. E. Newbury, scientists in the NBS Institute for Materials Research.

The publication is the formal report of the workshop on Secondary Ion Mass Spectrometry (SIMS) and Ion Microprobe Mass Analysis held at NBS in September 1974. The book presents a series of papers by experts on the principles of SIMS instrumentation, theory and applications in selected fields.

Topics covered in the papers include design of SIMS instrumentation, factors affecting secondary ion collection, techniques of reducing secondary ion mass spectra to yield quantitative compositional information, comparisons of SIMS with Auger electron spectroscopy, techniques of obtaining elemental depth profiles and the instrumental and physical factors affecting such profiles, and applications of SIMS to the study of geological samples.

The use of SIMS in the field of microanalysis is still in the initial phases of exploration, but already the technique has been shown to have several outstandingly attractive features.

For example, SIMS has been used to observe elements of low atomic number, to measure isotope ratios, and to carry out shallow depth sampling.

These studies have already produced exciting results in diverse fields of application, including the study of distribution in depth of dopants and impurities in semiconductor materials, the characterization of the microscopic distribution of hydrogen and boron in alloys and the analysis of microscopic particles.

On the other hand, the experimental difficulties and instrumental limitations, the uncertainties involving theoretical models of ion-target interaction and the serious problem in obtaining appropriate standards have vexed researchers involved in the practice of ion probe microanalysis. In addition, the cost of buying and maintaining SIMS instruments is very high, and, in fact, only about 50 SIMS instruments exist worldwide.

The NBS publication is intended to provide prospective SIMS users with information that will help them assess the potential gains and limitations of the technique applied to their specific needs.

NBS Special Publication 427 on Secondary Ion Mass Spectrometry is available at $3.00 a copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order by S.D. Catalog No. C13.10:427. Add 25 percent additional for other than U.S. mailing. ☐

Standard Issued for Police Portable Transceiver Batteries

A voluntary standard which sets forth performance and labeling requirements as well as test methods applicable to batteries used by police in radio transmitting and receiving units has recently been issued.

The standard was formulated by the Law Enforcement Standards Laboratory (LESL) of the National Bureau of Standards for the Justice Department's Law Enforcement Assistance Administration (LEAA) through its National Institute of Law Enforcement and Criminal Justice (NILECJ).

The standard covers three classifications of disposable batteries and two classifications of rechargeable batteries used in police personal/portable transceivers:

—*Disposable Batteries*
- mercury (mercuric oxide)
- alkaline (alkaline manganese)
- carbon-zinc (Leclanche)

—*Rechargeable Batteries*
- nickel-cadmium, slow charge
- nickel-cadmium, fast charge

NILECJ has approved and issued the new voluntary product standard under priorities established in cooperation with hundreds of police departments throughout the United States.

Fifty-six percent of departments responding to a 1972 LEAA/NBS police equipment survey said that they needed standards for portable radio batteries. Particular interest was expressed in batteries that would be smaller, lighter, longer lasting and more powerful.

Designated as NILECJ-STD-0211.00, the standard spells out requirements for personal/portable transceiver batteries considered to be of superior quality and suitable for law enforcement use.

Police purchasing agents can use the standard's test methods to determine first-hand whether a particular equipment item meets the requirements, or they may have the tests conducted on their behalf by a qualified testing laboratory. NILECJ-STD-0211.00 may also be referenced in police purchase documents detailing the requirements to be met by equipment suppliers.

As a technical resource of the LEAA program, LESL develops new and improved techniques, systems and equipment to support law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

Established by an interagency agreement between NBS and LEAA in 1971, LESL is supplying the law enforcement community with technical reports, user guidelines, and voluntary standards for equipment.

Current LESL activities address communications equipment, security systems, investigative aids, protective equipment, police vehicles, court systems, and other aspects of law enforcement. ☐

New RF Power Meter Design Available to Manufacturers

A new design for a power meter intended for measuring rf or microwave power (and also applicable to hot-wire anemometers) is available for licensing to manufacturers from the National Bureau of Standards.

Developed by Neil T. Larsen of the Electromagnetics Division at the NBS Boulder laboratories, the Type IV Power Meter avoids three inherent problems associated with previous designs based on the Wheatstone bridge. Instead of a bridge, a pair of high-gain differential amplifiers and a pair of dual power supplies are used to establish equal current and voltages across a reference resistor and the power sensor (thermistor, bolometer, barreter, hot wire, etc.).

The effect is to remove errors due to low common-mode rejection ratio, unknown sensor lead resistance, and most important, reduced degradation of signal/noise ratio at low measured power levels.

The power measurement is made by measuring the voltage (at equilibrium) across the power sensor before the rf is applied, and then during its application. The rf power is then calculated from these voltages and the known value of the reference resistor. The circuit is designed to be compatible with automated and digital measurement systems.

Manufacturers interested in commercially producing or using this instrument under NBS license may obtain a copy of the patent application and information about licensing from David Robbins, NBS Patent Advisor, National Bureau of Standards, Washington, D.C. 20234. Requests for the information should be accompanied by:

1) Name, address, and citizenship of inquirer,
2) State of incorporation, if applicable,
3) Location(s) of principal place of business and of manufacturing plant,
4) Nature of business engaged in,
5) Experience in field of power measurements,
6) Purpose for which license would be used, if obtained.

While the patent application explains the theory and mode of operation and shows generalized schematics of the circuit, more specific details will be made available via consultation with Mr. Larsen, National Bureau of Standards, Boulder, Colo. 80302, (303) 499-1000, ext. 3711. ☐

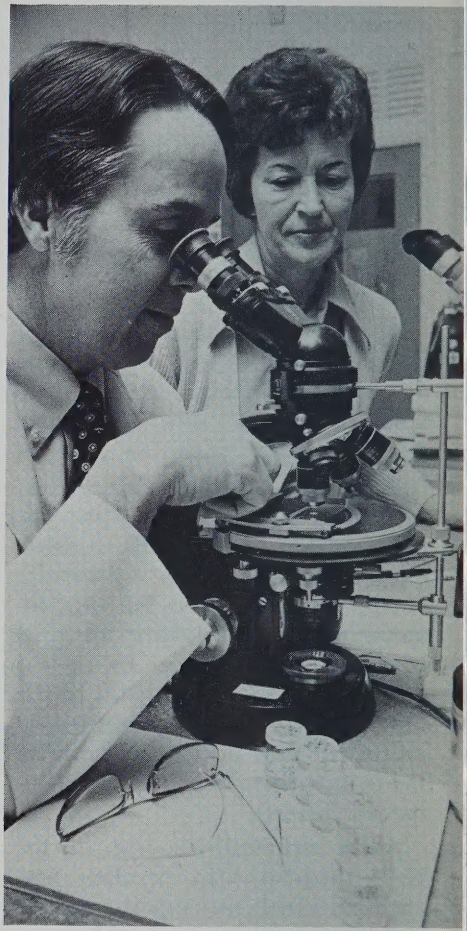
Phase separation is the breakdown of a material into homogeneous, distinct components that are separated by definite boundaries. (You can think of a salad dressing breaking down into separate levels of oil and vinegar.) When certain glasses are heated to the proper temperature and carefully cooled, they separate into two phases, one is almost pure silica and other contains most of the rest of the materials in the glass.

When the tiny glass particles or beads that make up a composite resin filler are treated in this way, what is left is a particle in which the separate phases—silica and glass—interlock and twist through each other in continuous interpenetrating networks. If an acid is applied to the surface of the beads, the glass phase near the surface dissolves and is etched away, leaving the more resistant silica behind, laced with a series of microscopic valleys and caverns. The pits are not very deep, since the acid touches only the surface of the tiny beads, but they should be deep enough to allow the plastic binder to penetrate into the crevices and lock the glass particles tightly in place.

A recent discovery by the ADA team was a number of glass compositions that have this phase separation quality, together with properties that are important to dental composites. The ingredients are non-toxic, and the glass is X-ray opaque. On a dental X-ray film, the filling shows up distinct from the tooth material, an important feature for making follow-up checks of the conditions of the tooth and filling many years later.

In addition, the refractive index of the glass closely matches that of the plastic binder. This is important for the patient, as the filling must blend with the tooth inconspicuously in color and translucence. The refractive indices of the various components affect the translucence of the finished filling.

Dr. Rafael Bowen and Louise Reed of the ADA Health Foundation Research Unit examine the etching effect of acid on a sample of tiny glass particles.



Although Bowen and his associates believe that this idea is basically sound, a good deal of research must be done before such materials get to the marketplace. In further experiments, they will try to determine the most efficient depth for the etching, since the depth of the crevices in the glass particle affects not only the strength of the final bond but also the translucence of the finished composite. The researchers will also test various glass additives to adjust the solubility of the glass.

Members of the research team working on this project include Dr. R. L. Bowen and L. E. Reed, of the ADA Health Foundation Research Unit at NBS, and Dr. W. K. Haller, D. H. Blackburn and D. A. Kauffman of NBS. ☐

PUBLICATIONS

# of the National Bureau of Standards

Computer Science and Technology

O'Neill, J. T., Ed., *MUMPS Language Standard,* Nat. Bur. Stand. (U.S.), Handb. 118, 144 pages (Dec. 1975) SD Catalog No. C13.11:118.

Consumer Information and Protection:

Hasko, S., *Examination of Vapor-Measuring Devices for Liquefied Petroleum Gas. A Manual for Weights and Measures Officials,* Nat. Bur. Stand. (U.S.), Handb. 117, 25 pages (Dec. 1975) SD Catalog No. C13.11:117.

Electromagnetic Metrology

Barnes, J. A., and Beehler, R. E., *Report on the 1975 Survey of Users of the Services of Radio Stations WWV and WWVH,* Nat. Bur. Stand. (U.S.), Tech. Note 674, 91 pages (Oct. 1975) SD Catalog No. C13.46:674, $1.50.

Larson, W., *The Rotary-Vane Attenuator as an Interlaboratory Standard,* Nat. Bur. Stand. (U.S., Monogr. 144, Oct. 1975) SD Catalog No. C13.44:144.

Energy Conservation and Production

Massey, R. G., Ed., *Energy Conservation Program Guide for Industry and Commerce (EPIC),* Nat. Bur. Stand. (U.S.), Handb. 115, Suppl. 1, 212 pages (Dec. 1975) SD Catalog No. C13.11:115, $2.90.

Engineering, Product and Information Standards

Chumas, S. J., Ed., *Directory of United States Standardization Activities,* Nat. Bur. Stand. (U.S.), Spec. Publ. 417, 228 pages (Nov. 1975) SD Catalog No. C13.10:417.

Vickers, M. V., *COBOL,* Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 21-1, (Dec. 1, 1975) SD Catalog No. C13.52:21-1.

Wood, J. F., *Guidelines for Benchmarking ADP Systems in the Competitive Procurement Environment,* Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 42, 8 pages (Dec. 1975) SD Catalog No. C13.52:42.

Failure Analysis

Shives, T. R., and Willard, W. A., Eds., *Detection, Diagnosis, and Prognosis,* Nat. Bur. Stand. (U.S.), Spec. Publ. 436, 366 pages (Dec. 1975) SD Catalog No. C13.10:436.

Instrumentation and Experimental Methods

Crist, R. A., Marshall, R. D., and Laursen, H. I., *Electro-Optical Deflection Measuring Device,* Nat. Bur. Stand. (U.S.), Tech. Note 873, 24 pages (Dec. 1975) SD Catalog No. C13.46:873, 75 cents.

Mathematical and Statistical Methods

Deprit, A., *Ideal Elements for Perturbed Keplerian Motions,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 1-15 (Jan.-June 1975).

Feinberg, R. B., *Similarity of Partitioned Matrices,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 3 and 4, (July-Dec. 1975).

Ferreira, G. F. L., Oliveira, L., Nunes de, and Gross, B., *Charge Profiles in Parallel-Plate Ionization Chambers,* Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 65-78 (Jan.-June 1975).

Johnson, C. R., *Two Submatrix Properties of Certain Induced Norms,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 3 and 4, (July-Dec. 1975).

Johnson, C. R., and Newman, M., *A Condition for the Diagonalizability of a Partitioned Matrix,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 45-48 (Jan.-June 1975).

Kearsley, E. A., and Fong, J. T., *Linearly Independent Sets of Isotropic Cartesian Tensors of Ranks up to Eight,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 49-58 (Jan.-June 1975).

Minieka, E., *Maximal Network Flows, Matroids and Matchings,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 59-62 (Jan.-June 1975).

Okui, S., *Complete Elliptic Integrals Resulting from Infinite Integrals of Bessel Functions, II.,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 3 and 4, (July-Dec. 1975).

Page, C. H., *On the Dimension Group of Classical Physics,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 3 and 4, (July-Dec. 1975).

Sabella, R. R., *A Note on the Metirzability of Spaces with Countably Based Closed Sets,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 63-69 (Jan.-June 1975).

Sabella, R. R., *Properties of Neighboring Sequences in Stratifiable Spaces,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 3 and 4, (July-Dec. 1975).

Sinha, T. N., *The Diophantine Equation* $p^2x^4 + 3px^2y^2 + y^4 = z^2$, *p An Odd Prime.* J Res. Nat. Bur. Stand. (U.S.), 79B (Math. Sci.), Nos. 1 and 2, 41-44 (Jan.-June 1975).

Slater, P. J., *Maximin Facility Location,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 3 and 4, (July-Dec. 1975).

Yaghjian, A. D., *Generalized or Adjoint Reciprocity Relations for Electroacoustic Transducers,* J. Res. Nat. Bur. Stand. (U.S.), *79B* (Math. Sci.), Nos. 1 and 2, 17-39 (Jan.-June 1975).

Properties of Materials: Structural and Mechanical

Breedon, J. E., and Geil, P. H., *Surface Films on Polyoxymethylene Single Crystals,* J. Res. Nat. Bur. Stand. (U.S.), *79A* (Phys. and Chem.), No. 5, 609-611 (Sept.-Oct. 1975).

Dickens, B., Schroeder, L. W., *Computer Programs for Structural Chemistry: MATCH 1 and MATCH 2, FORTRAN Programs to Predict and Evaluate Mutual Orientation of Polycrystals,* Nat. Bur. Stand. (U.S.), Tech. Note 893, 159 pages (Dec. 1975) SD Catalog No. C13.46:893.

Hoffman, J. D., and Davis, G. T., *On the Origin of the Amorphous Component in Polymer Single Crystals and the Nature of the Fold Surface,* J. Res. Nat. Bur. Stand. (U.S.), *79A* (Phys. and Chem.), No. 5, 613-617 (Sept.-Oct. 1975).

Hoffman, J. D., Frolen, L. J., Ross, G. S., and Lauritzen, J. I., Jr., *On the Growth Rate of Spherulites and Axialites from the Melt in Polyethylene Fractions: Regime I and Regime II Crystallization,* J. Res. Nat. Bur. Stand. (U.S.), *79A* (Phys. and Chem.), No. 6, (Nov.-Dec. 1975).

Ross, G. S., Frolen, L. J., *Homogeneous Nucleation in Polyethylene: Molecular Weight Dependence,* J. Res. Nat. Bur. Stand. (U.S.), *79A* (Phys. and Chem.), No. 6, (Nov.-Dec. 1975).

Publications listed here may be purchased at the listed price from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, Va. 22151. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

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